ANALYSIS OF AVIATION CLASS A/B/C MISHAPS AND AVIATION SAFETY SURVEYS

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INTRODUCTION

Aviation safety surveys are an important aspect of the Naval Safety Center mission. This study examined the relationship between the safety survey and aviation mishap rates to determine if the surveys actually prevent mishaps. Specifically, the study will analyze:

- What were the corresponding mishap rates?
- Was there a noticeable trend that can be correlated to survey administration?
- Were there significant changes that coincide with survey administration?

METHODOLOGY

Each aviation safety survey by date and squadron dating back to fiscal year 2005 was obtained from the Naval Safety Center Aviation Directorate. In general, a squadron received an aviation safety survey approximately every three years. For this reason, it was decided to extract the mishap rates one year prior to the survey, one year after the survey, and two years after the survey. The three rates would be compared to determine if there was a statistically significant difference.

Only active aircraft were included. Data for the F-14 and S-3 were not included in the study. Also excluded was data from the training command. Many training command mishaps in the NSC database were assigned to the wing and not to the squadron. This made it impossible to match some training command mishaps with a squadron. Leaving out some training command mishaps and including others would skew the data so it was decided to perform the analysis without the training command data.

Additionally it will be seen from the data that different aircraft communities had different mishap rates. The best way to compare mishap rates prior to and after surveys was to separate the data by communities. It was also decided to analyze the HSL community separate from the other H-60 communities. The reason was that the HSL community operated on a detachment concept while the other communities did not. For those who are still interested in viewing combined rates, a summary of combined rates crossing all communities was provided.

NAVY CLASS A/B/C MISHAPS

Figure 1 compares the mishap rate one year prior to a safety survey to the rates one and two years after the survey. The table only included survey data through March of 2009

because dates after March 2009 did not allow a full two years after completion of the survey.

	ONE YEAR PRIOR			ONE YEAR AFTER			TWO YEARS AFTER		
Community	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
VFA	49	187,652	26.11	48	176,568	27.18	97	370,586	26.17
VAQ	6	24,799	24.19	10	23,784	42.04	17	49,381	34.43
VP	9	38,581	23.33	4	29,270	13.67	10	64,880	15.41
HSL	4	52,735	7.59	3	49,998	6.00	4	99,836	4.01
HS	12	66,870	17.95	13	75,404	17.24	24	150,517	15.95
VR	1	40,148	2.49	5	40,140	12.46	9	80,534	11.18
Total	81	410,785	19.72	83	395,165	21.00	161	815,734	19.74

Fig 1: Navy A/B/C Mishap Rates (FY2006 – March 2009)

What do the rates mean? To determine if there was a significant difference in the rates, Fisher's F-test at the 95% level was used. If a calculated p-value was greater than .05, this meant that there was no significant difference between the two rates. Figure 2 summarizes the results.

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value	ONE YEAR PRIOR	TWO YEARS AFTER	p-value
VFA	26.11	27.18	0.92	26.11	26.17	1.00
VAQ	24.19	42.04	0.32	24.19	34.43	0.52
VP	23.33	13.67	0.42	23.33	15.41	0.36
HSL	7.59	6.00	1.00	7.59	4.01	0.46
HS	17.95	17.24	1.00	17.95	15.95	0.72
VR	2.49	12.46	0.13	2.49	11.18	0.18
Total	19.72	21.00	0.70	19.72	19.74	1.00

Fig 2: Fisher's Test (FY2006 - March 2009)

It can be seen that in each case, the p-value was greater than .05 meaning that at the 95 percent confidence level there was no significant difference between the rates one year prior to a safety survey and one/two years after a safety survey.

If the rates from one year prior to a survey are compared only with the rates one year after the survey, more data may be analyzed. In this instance, a comparison can be made for surveys through March of 2010. Figure 3 shows the results of this comparison.

	ONE YEAR PRIOR			ONE YEAR AFTER		
Community	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
VFA	66	272,768	24.20	66	258,913	25.49
VAQ	6	28,049	21.39	10	26,780	37.34
VP	16	58,913	27.16	7	59,289	11.81
HSL	7	90,155	7.76	7	87,014	8.04
HS	15	89,443	16.77	15	104,829	14.31
VR	5	59,214	8.44	7	59,622	11.74
Total	115	598,543	19.21	112	596,447	18.78

Fig 3: Navy A/B/C Mishap Rates (FY 2006 - March 2010)

The corresponding p-values (all greater than .05) are:

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value
VFA	26.11	25.49	0.79
VAQ	24.19	37.34	0.32
VP	23.33	11.81	0.06
HSL	7.59	8.04	1.00
HS	17.95	14.31	0.72
VR	2.49	11.74	0.77
Total	19.72	18.78	0.89

Fig 4: Fisher's Test (FY2006 - March 2010)

Figure 5 shows a scatter plot that represents the number of days after a survey (up to two years) vs the number of mishaps. Again, in order to have two full years, the data is limited to surveys prior to March of 2009. The linear nature of the plot shows that for up to 730 days (two years) there was no increase or decrease in frequency of mishaps the further away in days after a survey. Please see Appendix A for a scatter plot of the individual navy aircraft communities.
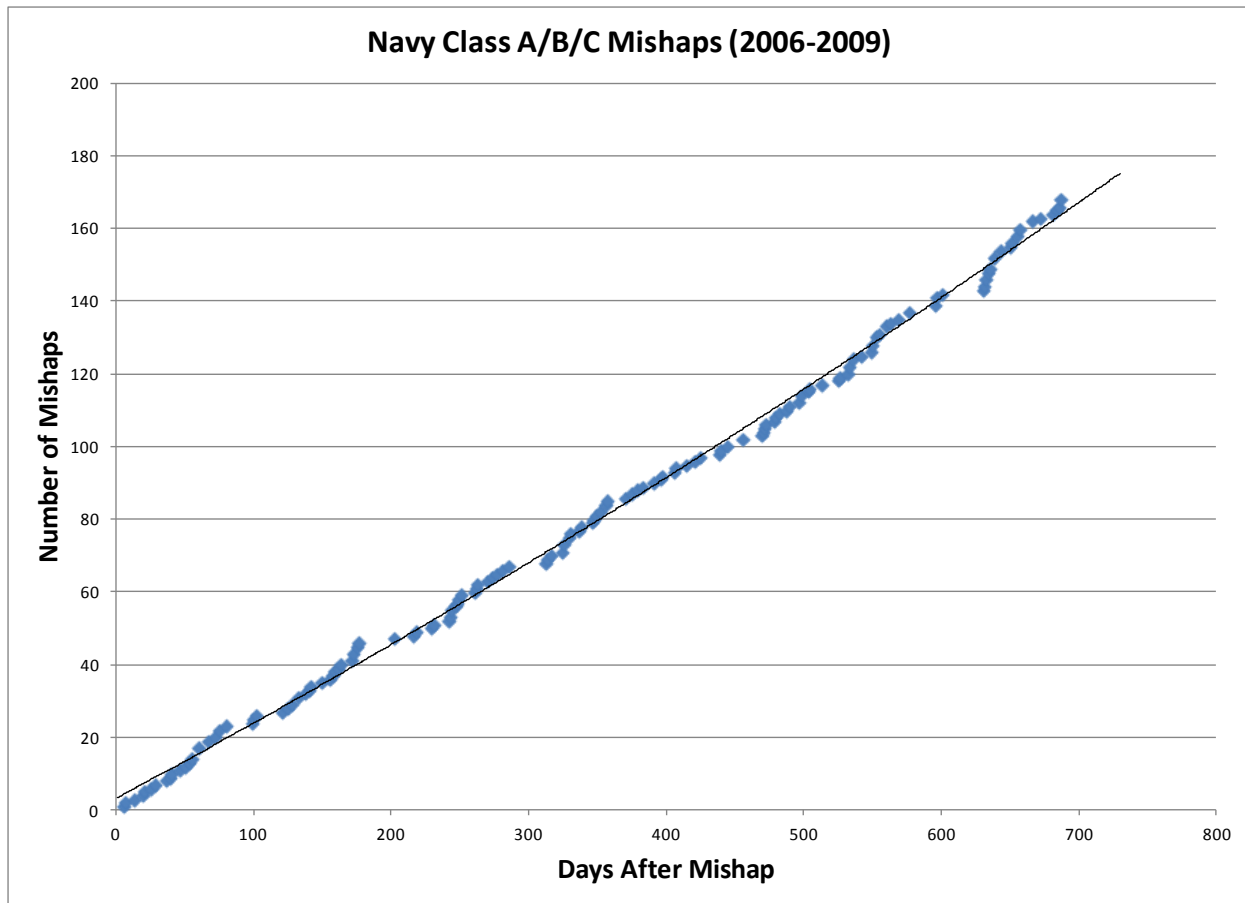
Fig 5: Days After Survey vs Number of Class A/B/C Mishaps

NAVY CLASS A MISHAPS

Class A mishaps are analyzed in an identical manner as the class A/B/C. Figure 6 compares one year prior to the survey with one and two years after the survey.

	ONE YEAR PRIOR			ONE YEAR AFTER			TWO YEARS AFTER		
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
VFA	7	187,652	3.73	4	176,568	2.27	7	370,586	1.89
VAQ	3	24,799	12.10	0	23,784	0.00	0	49,381	0.00
VP	0	38,581	0.00	0	29,270	0.00	1	64,880	1.54
HSL	0	52,735	0.00	0	49,998	0.00	0	99,836	0.00
HS	2	66,870	2.99	3	75,404	3.98	6	150,517	3.99
VR	1	40,148	2.49	1	40,140	2.49	1	80,534	1.24
Total	13	410,785	3.16	8	395,165	2.02	15	815,734	1.84

Fig 6: Navy Class A Mishap Rates (FY2006 – March 2009)

The results of Fisher's test are presented in figure 7. The normal approximation may be inaccurate because of the small number of class A mishaps per community. For this reason figure 7 only shows the test results for overall class A mishaps.

4

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value	ONE YEAR PRIOR	TWO YEARS AFTER	p-value
Total	3.16	2.02	0.39	3.16	1.84	0.16

Fig 7: Fisher's Test (FY2006 - March 2009)

The p-values are greater than .05 implying that there was no significant difference at the 95 percent confidence level between the class A mishap rates one year prior to a survey and one and two years after a survey.

Figure 8 displays the comparison for one year prior to the survey and only one year after.

	ONE YEAR PRIOR			ONE YEAR AFTER		
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
VFA	7	272,768	2.57	6	258,913	2.32
VAQ	3	28,049	10.70	0	26,780	0.00
VP	0	58,913	0.00	0	59,289	0.00
HSL	0	90,155	0.00	0	87,014	0.00
HS	2	89,443	2.24	3	104,829	2.86
VR	1	59,214	1.69	0	59,622	0.00
Total	13	598,543	2.17	9	596,447	1.51

Fig 8: Navy Class A Mishap Rates (FY 2006 – March 2010)

The p-value (both greater than .05) for the overall totals:

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value
Total	2.17	1.51	0.52

Fig 9: Fisher's Test (FY2006 - March 2010)

A scatter plot of navy class A mishaps is shown in figure 10. For class A mishaps there is a slight increase in the mishap frequency commencing at approximately 325 days, but as shown previously the increase is not statistically significant.
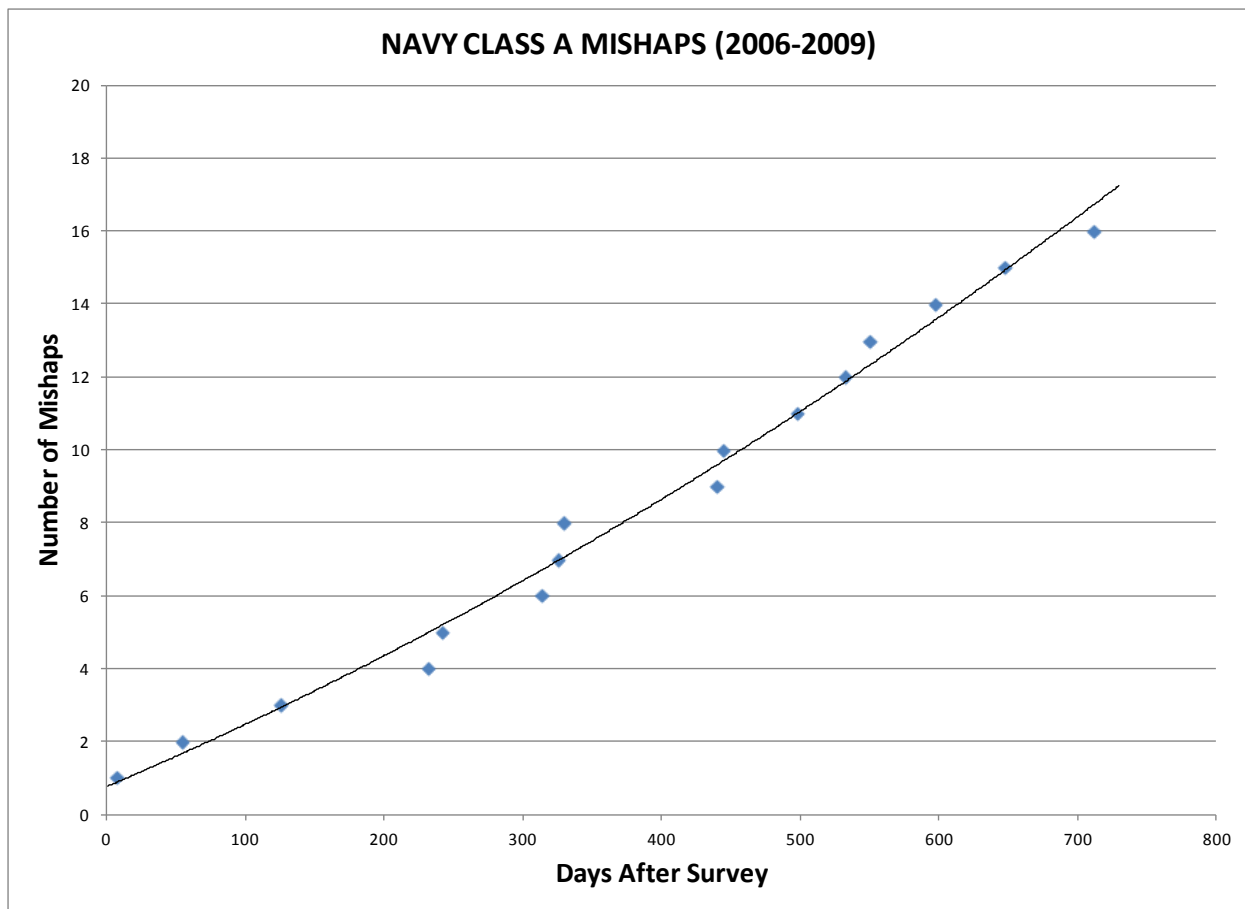
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NAVY CLASS A MISHAPS (2006-2009)

Fig 10: Days After Survey vs Number of Class A Mishaps

MARINE CORPS CLASS A/B/C MISHAPS

The analysis of Marine Corps Class A/B/C mishaps was accomplished in the same manner as the Navy. Figure 11 shows the mishap rates by community.

Community	ONE YEAR PRIOR			ONE YEAR AFTER			TWO YEARS AFTER		
	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
Helicopter	12	116,816	10.27	7	120,438	5.81	15	237,565	6.31
Fighter/Attack	24	139,048	17.26	21	151,041	13.90	45	276,746	16.26
Transport/Tilt Rotor	4	35,024	11.42	5	45,402	11.01	11	90,866	12.11
Total	40	290,888	13.75	33	316,881	10.41	71	605,177	11.73

Fig 11: Marine Corps A/B/C Mishap Rates (FY2005 – March 2009)

The corresponding p-values are:

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value	ONE YEAR PRIOR	TWO YEARS AFTER	p-value
Helicopter	10.27	5.81	0.26	10.27	6.31	0.22
Fighter/Attack	17.26	13.90	0.55	17.26	16.26	0.80
Transport/Tilt Rotor	11.42	11.01	1.00	11.42	12.11	1.00
Total	13.75	10.41	0.24	13.75	11.73	0.42

Fig 12: Fisher's Test (FY2005 – March 2009)

All p-values are greater than .05 meaning that there was no significant difference in rates at the 95 percent confidence level.

Analyzing only one year prior and after yielded the following results in figure 13:

Community	ONE YEAR PRIOR			ONE YEAR AFTER		
	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
Helicopter	18	156,734	11.48	15	166,793	8.99
Fighter/Attack	32	160,921	19.89	28	176,039	15.91
Transport/Tilt Rotor	4	53,619	7.46	11	62,290	17.66
Total	54	371,274	14.54	54	405,122	13.33

Fig 13: Marine Class A/B/C Mishap Rates (FY 2005 – March 2010)

The corresponding p-values are:

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value
Helicopter	11.48	8.99	0.49
Fighter/Attack	19.89	15.91	0.44
Transport/Tilt Rotor	7.46	17.66	0.19
Total	14.54	13.33	0.70

Fig 14: Fisher's Test (FY2005 – March 2010)

Once again it can be seen that there is no significant difference at the 95 percent confidence level.

Figure 15 displays the scatter plot of Marine Corps class A/B/C mishaps. There is a small increase at day 371 and small decrease at day 542. Neither is significant. Please see Appendix B for scatter plots by Marine Corps community.
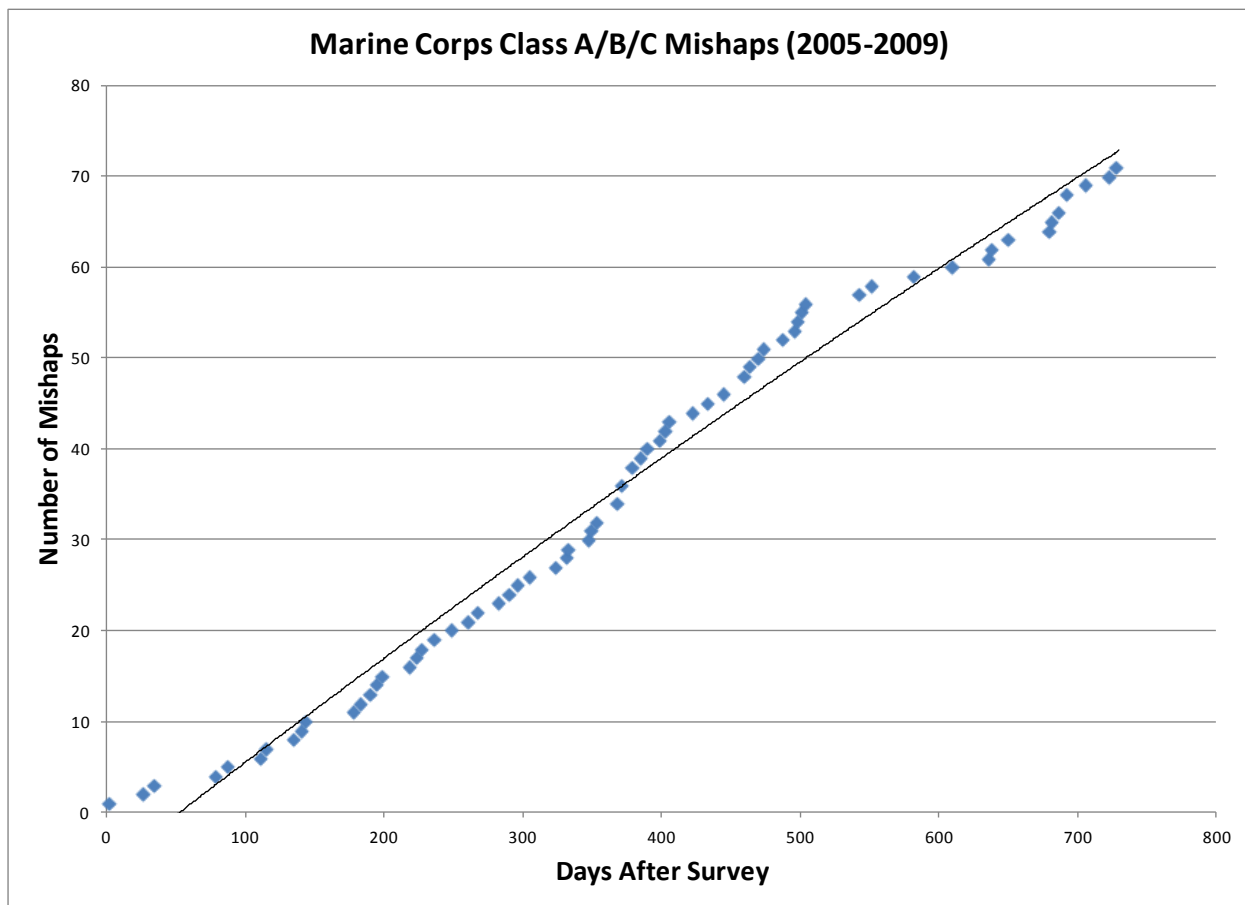
Marine Corps Class A/B/C Mishaps (2005-2009)

Fig 15: Days After Survey vs Number of Class A/B/C Mishaps

MARINE CORPS CLASS A MISHAPS

The class A analysis was conducted in a similar manner as the class A/B/C. Figure 16 displays the comparison of rates one year prior to the survey with the rates one and two years after the survey.

	ONE YEAR PRIOR			ONE YEAR AFTER			TWO YEARS AFTER		
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
Helicopter	4	116,816	3.42	2	120,438	1.66	3	237,565	1.26
Fighter/Attack	5	139,048	3.60	4	151,041	2.65	12	276,746	4.34
Transport/Tilt Rotor	1	35,024	2.86	1	45,402	2.20	1	90,866	1.10
Total	10	290,888	3.44	7	316,881	2.21	16	605,177	2.64

Fig 16: Marine Corps A Mishap Rates (FY2005 – March 2009)

As with the Navy analysis, the small numbers of class A mishaps means that only the combined totals will give an accurate result for p-values. Figure 17 shows the combined

results. It can be seen that the p-values denote no significant difference.

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value	ONE YEAR PRIOR	TWO YEARS AFTER	p-value
Total	3.44	2.21	0.47	3.44	2.64	0.53

Fig 17: Fisher's Test (FY2005 – March 2009)

Figure 18 shows the comparison when only the year prior and the year after was used.

	ONE YEAR PRIOR			ONE YEAR AFTER		
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
Helicopter	6	156,734	3.83	2	166,793	1.20
Fighter/Attack	7	160,921	4.35	4	176,039	2.27
Transport/Tilt Rotor	1	53,619	1.87	2	62,290	3.21
Total	14	371,274	3.77	8	405,122	1.97

Fig 18: Marine Corps A Mishap Rates (FY2005 – March 2010)

The corresponding combined p-value of .20 means no significant difference.

Community	ONE YEAR PRIOR	ONE YEAR AFTER	p-value
Total	3.77	1.97	0.20

Fig 19: Fisher's test (FY2005 – March 2010)

Figure 20 displays the scatter plot for Marine class A mishaps. Consistent with the Navy analysis, only surveys completed by March of 2009 were included to allow two full years after the survey. The scatter plot shows a slight increase in rate at approximately day 449 and a decrease at approximately day 542. Neither is significant.

9

Marine Corps Class A Mishaps (2005-2009)
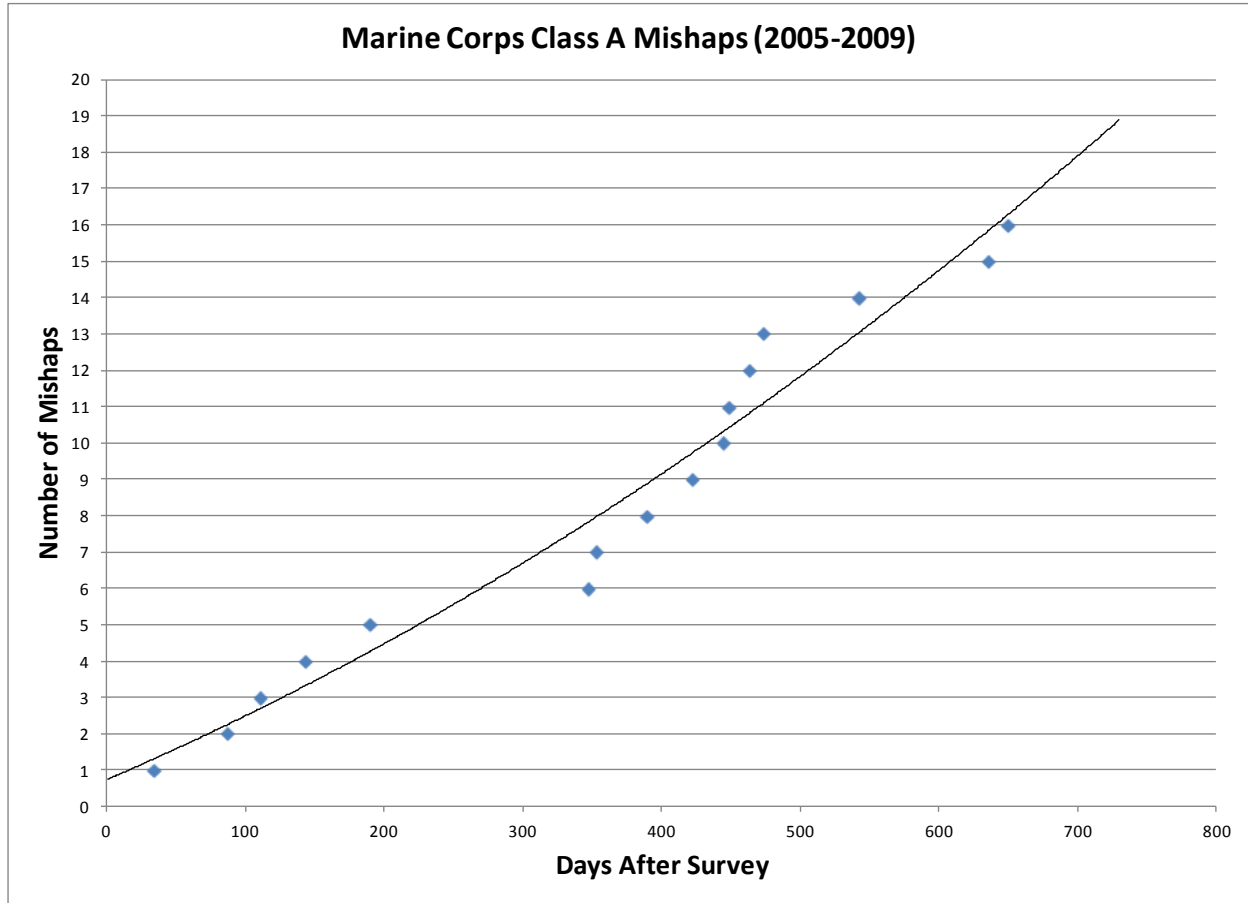
Fig 20: Days After Survey vs Number of Class A Mishaps

NAVY/MARINE CORPS CLASS A/B/C

Figure 21 and 22 display the combined Navy/Marine Corps survey rates. Figure 22 has more data through March 2010 because it only includes mishap that occurred within one year of the survey.

	ONE YEAR PRIOR			ONE YEAR AFTER			TWO YEARS AFTER		
Community	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
Navy	81	410,785	19.72	83	395,165	21.00	161	815,734	19.74
Marine	40	290,888	13.75	33	316,881	10.41	71	605,177	11.73
Total	121	701,673	17.24	116	712,046	16.29	232	1,420,911	16.33
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
Navy	13	410,785	3.16	8	395,165	2.02	15	815,734	1.84
Marine	10	290,888	3.44	7	316,881	2.21	16	605,177	2.64
Total	23	701,673	3.28	15	712,046	2.11	31	1,420,911	2.18

Fig 21: Combined Mishap Rates (FY2005 – March 2009)

	ONE YEAR PRIOR			ONE YEAR AFTER		
Community	A-B-C Mishaps	Flt Hrs	Rate	A-B-C Mishaps	Flt Hrs	Rate
Navy	115	598,543	19.21	112	596,447	18.78
Marine	54	371,274	14.54	54	405,122	13.33
Total	169	969,817	17.43	166	1,001,569	16.57
Community	A Mishaps	Flt Hrs	Rate	A Mishaps	Flt Hrs	Rate
Navy	13	598,543	2.17	9	596,447	1.51
Marine	14	371,274	3.77	8	405,122	1.97
Total	27	969,817	2.78	17	1,001,569	1.70

Fig 22: Combined Mishap Rates (FY 2005 – March 2010)

Figures 23 and 24 contain the combined scatter plots.
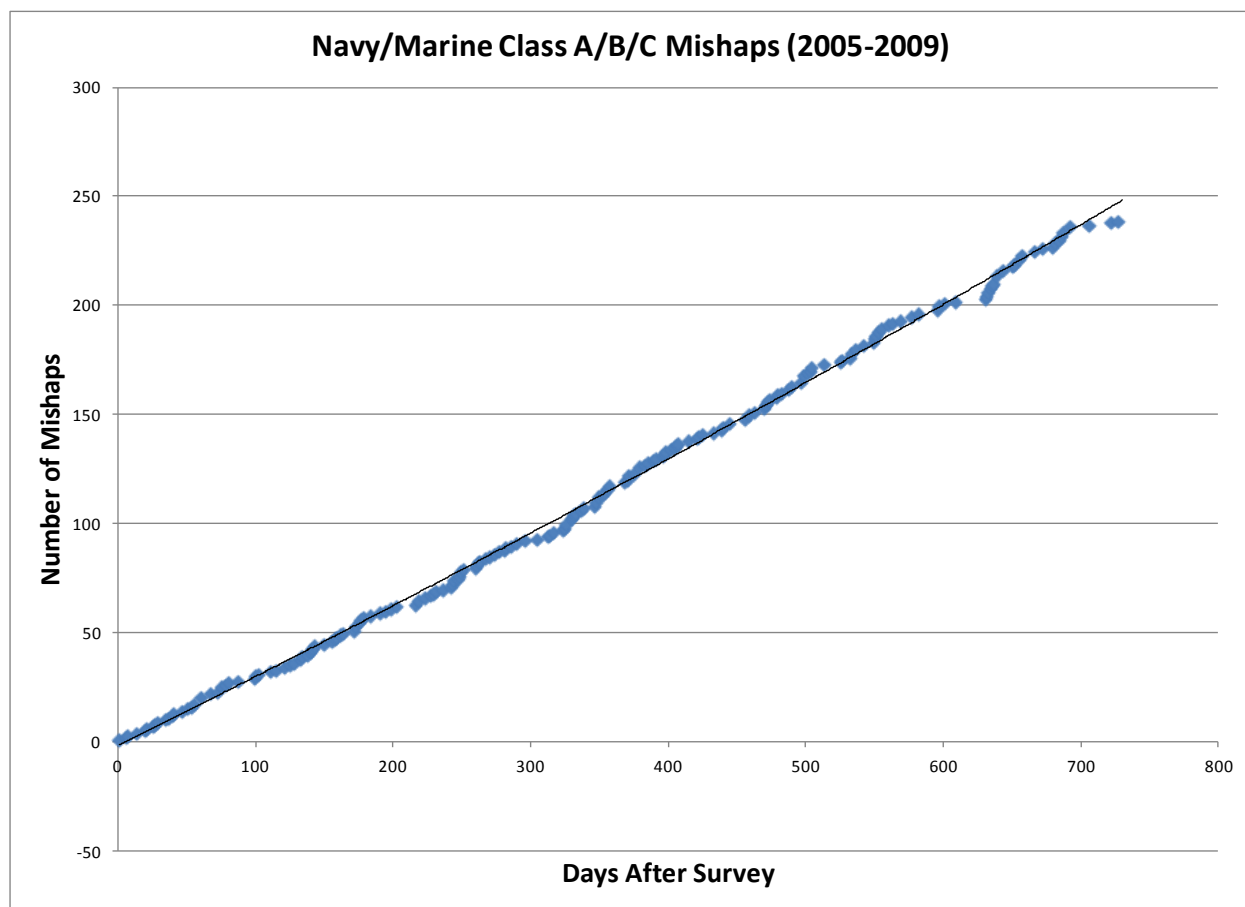
Fig 23: Days After Survey vs Number of Class A/B/C Mishaps
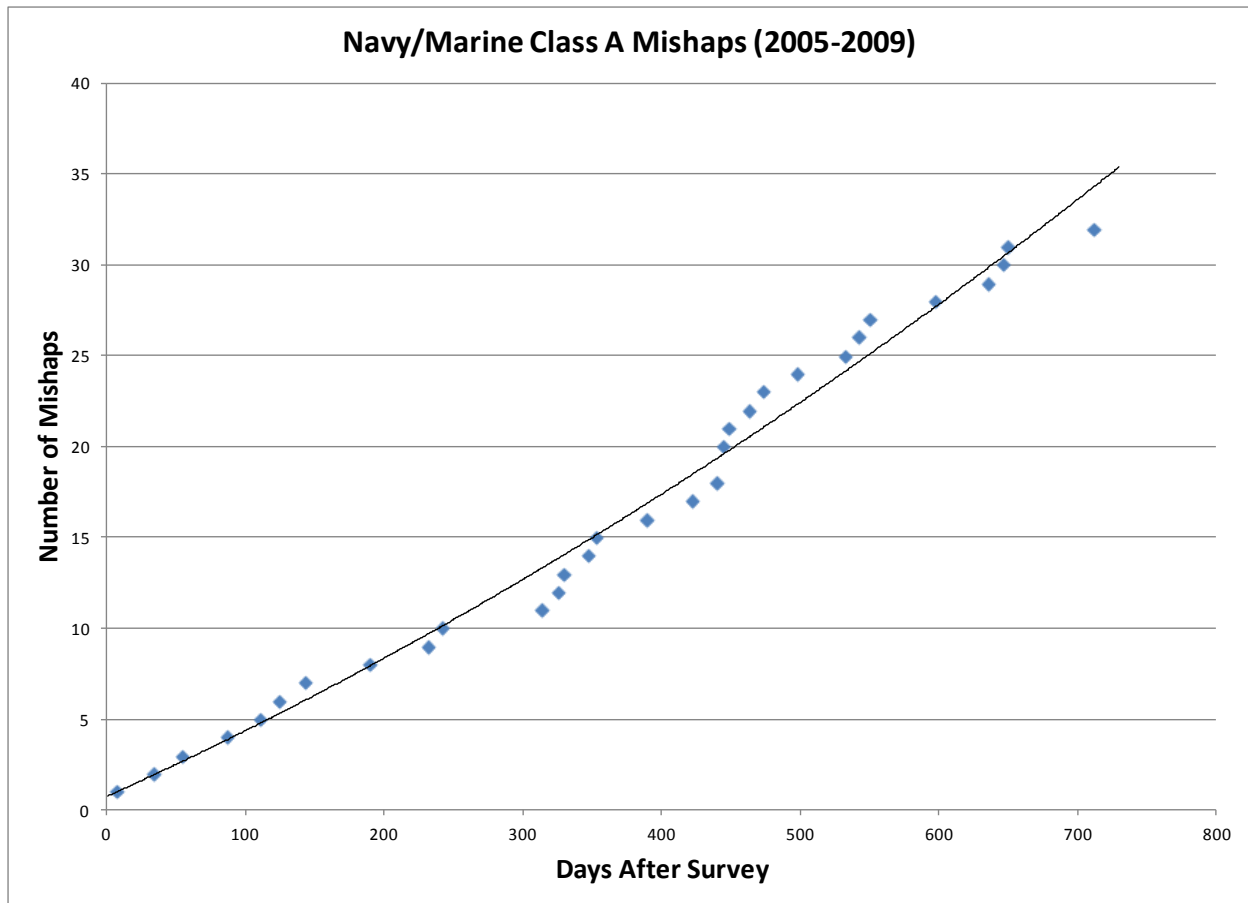
Fig 24: Days After Survey vs Number of Class A Mishaps

CONCLUSION

There was no statistically significant difference in the mishap rates when comparing the year prior to a safety survey with the first year after a survey and two years after the survey. This leads to a few conclusions. First, the policy in waiting three years between safety surveys is a correct one. The knowledge gained from the survey serves to prevent mishaps throughout the completion of a follow on survey. Consideration may be given to lengthening the time period between surveys to see if the effect of a survey last longer than three years.

Another possibility is that the survey has no effect on mishap prevention; however, it would not be desirable to have a few squadrons forgo a round of surveys to test this hypothesis.
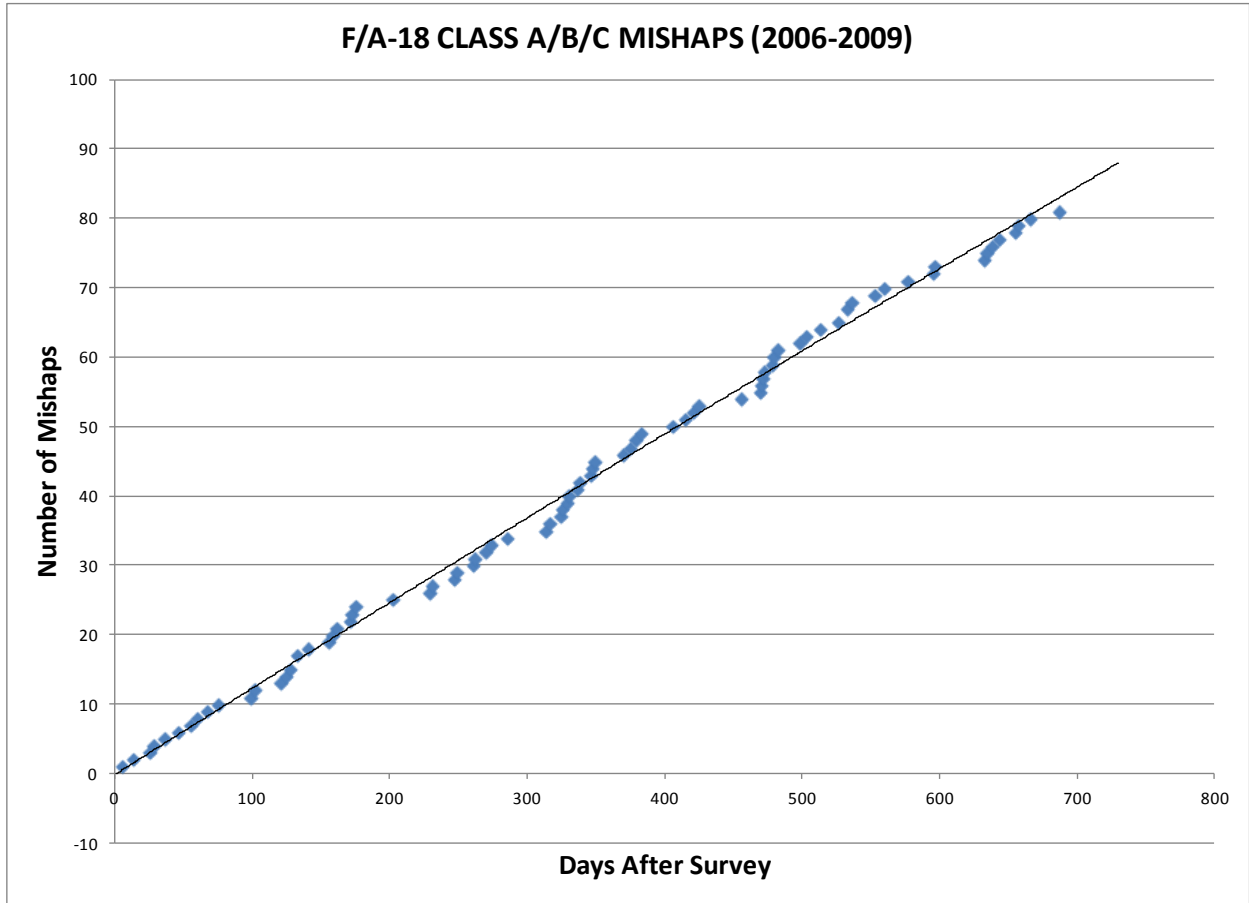
Fig A-1: F/A-18 Class A/B/C Mishaps
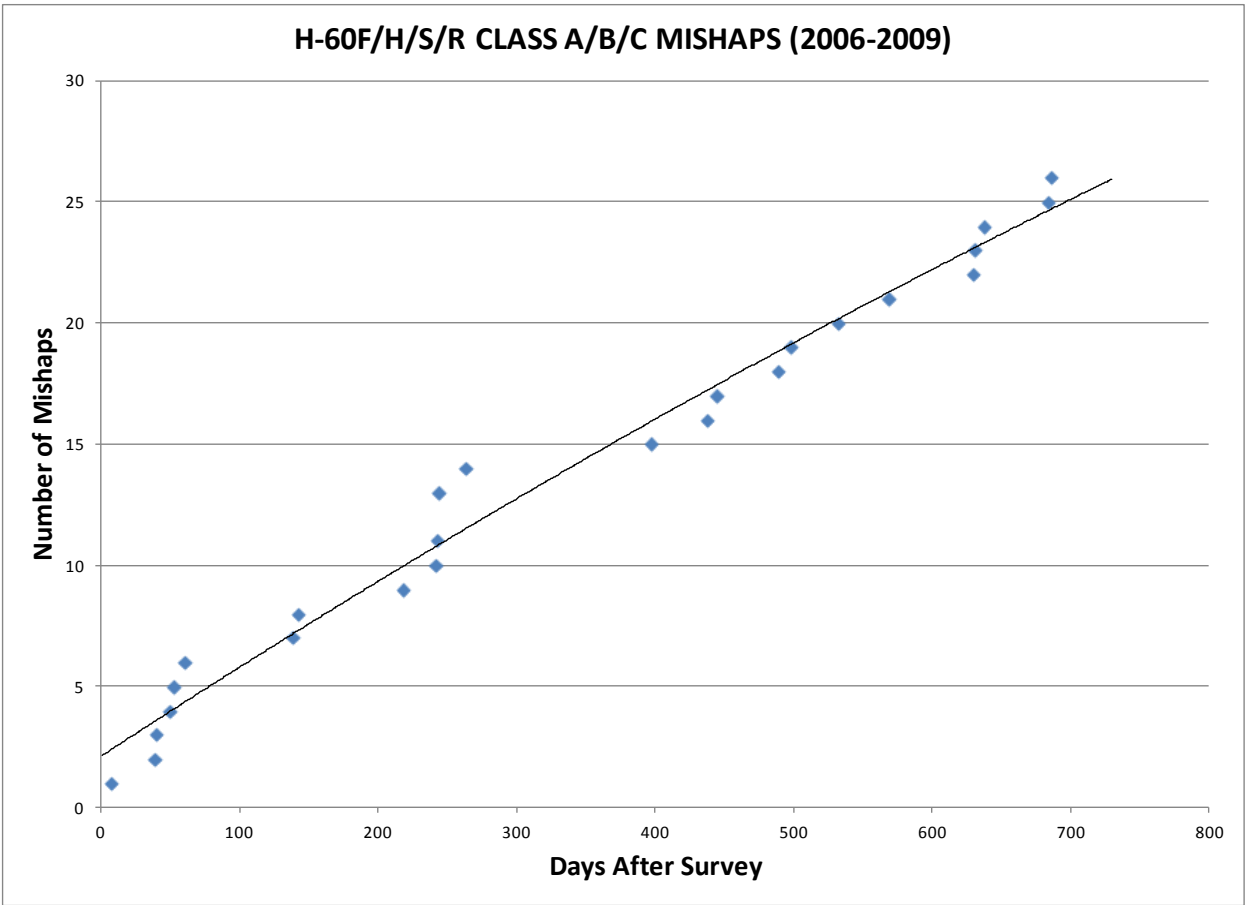
Fig A-2: H-60F/H/S/R Class A/B/C Mishaps
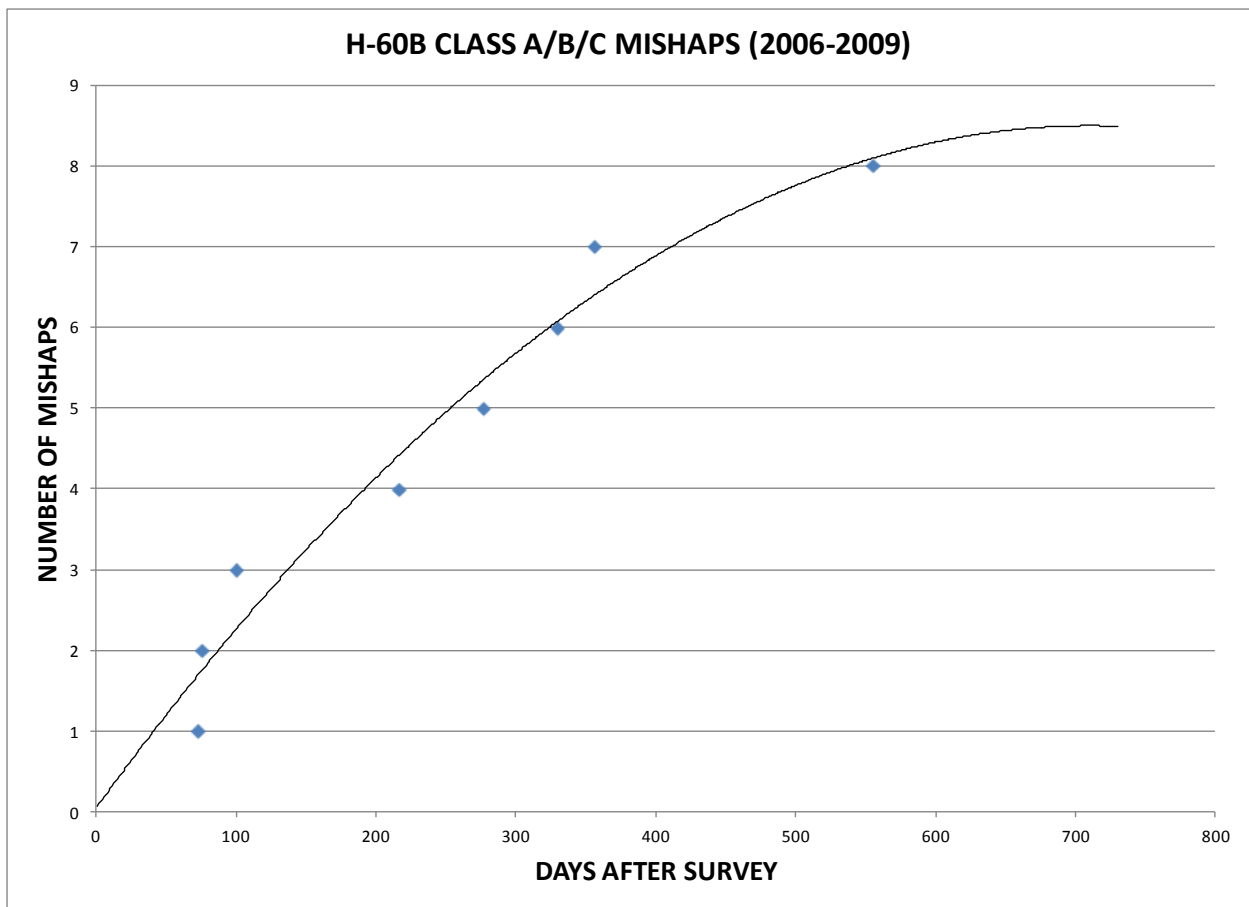
Fig A-3: H-60B Class A/B/C Mishaps
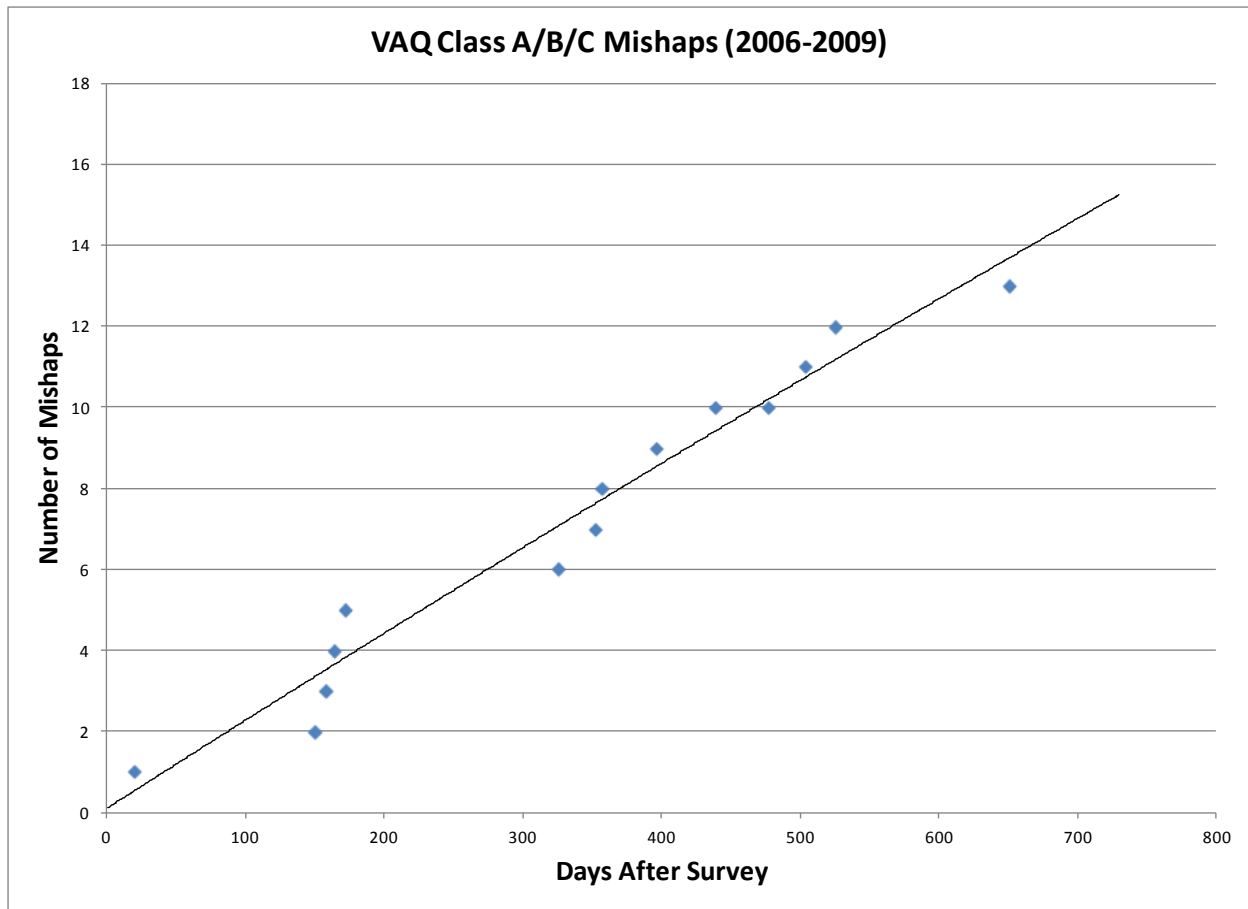
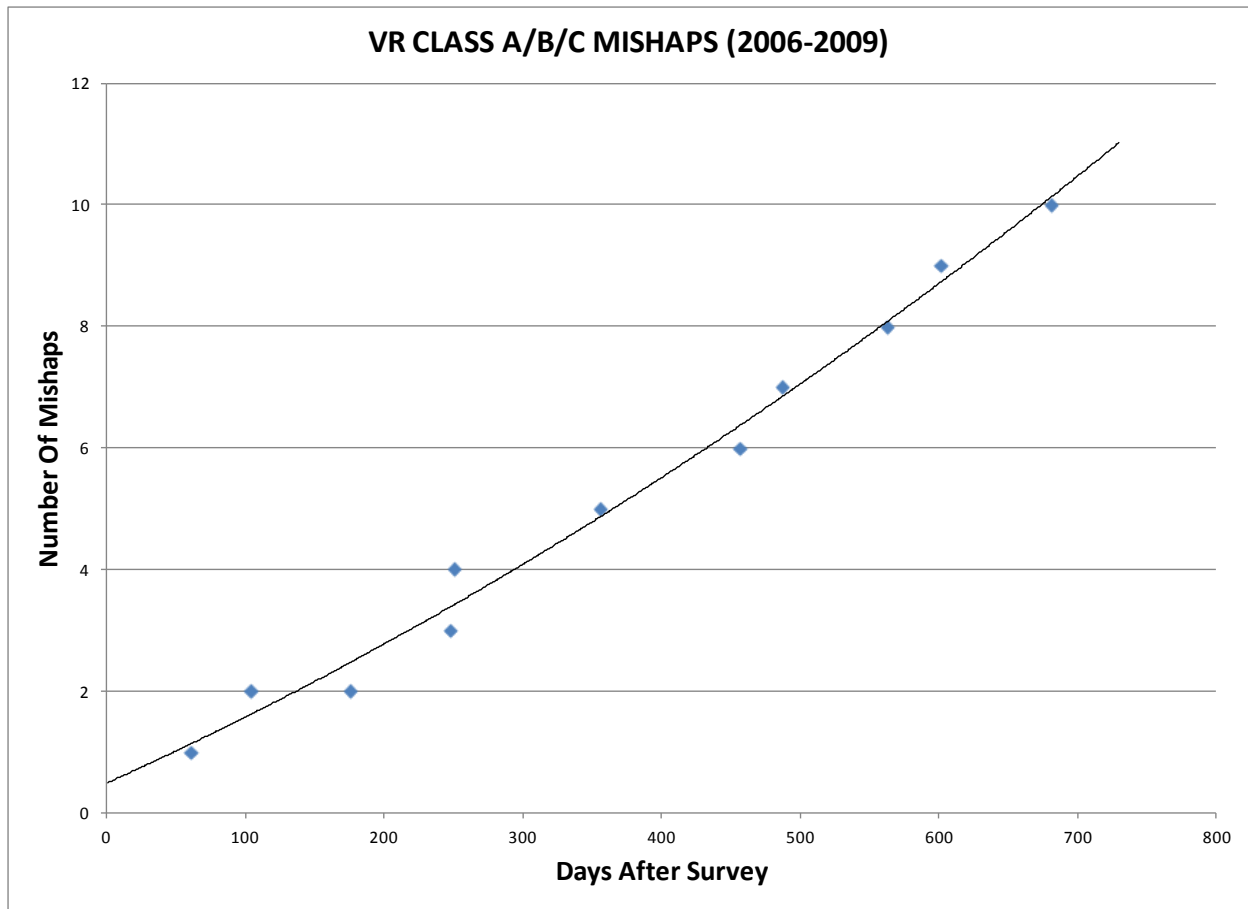Fig A-4: EA-6B Class A/B/C Mishaps
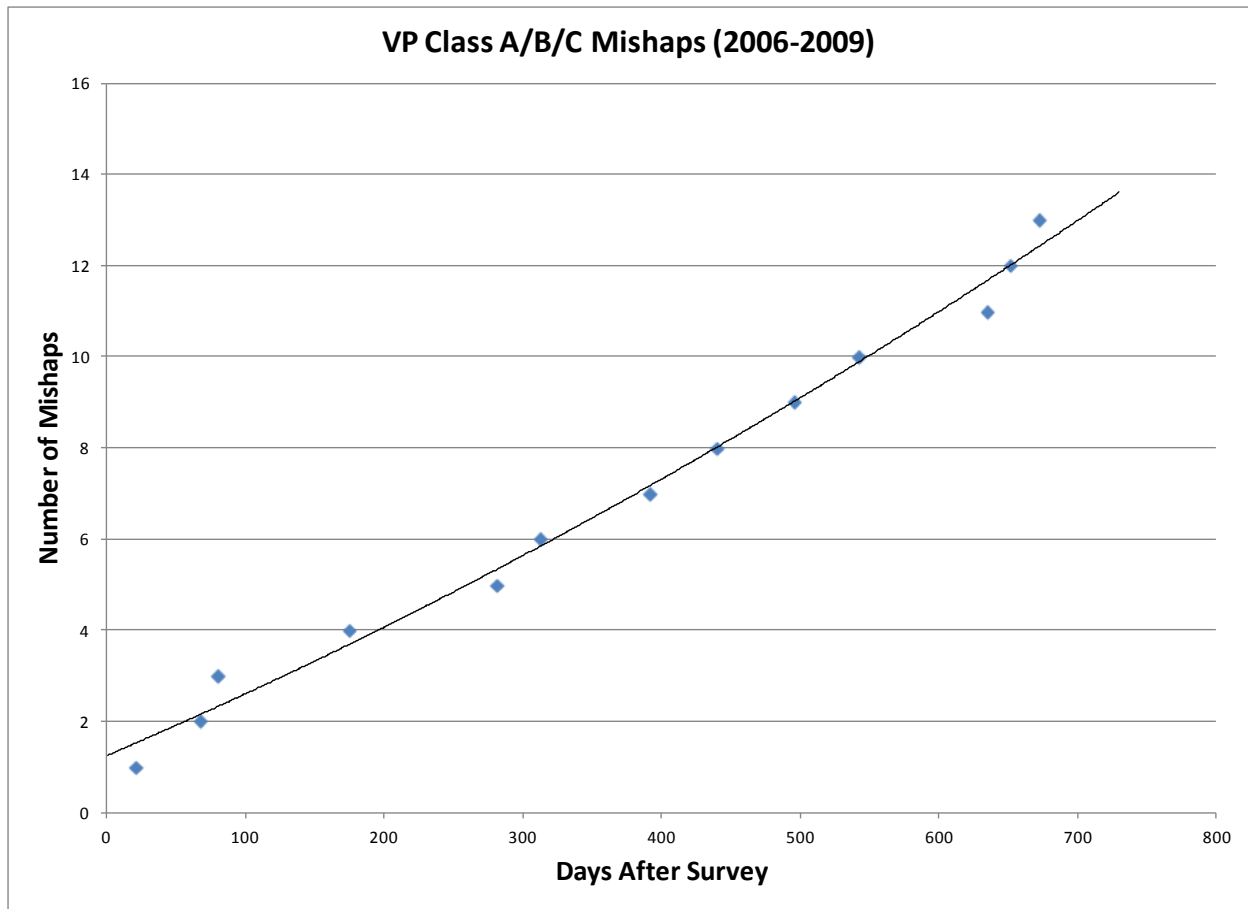
Fig A-5: P-3 Class A/B/C Mishaps

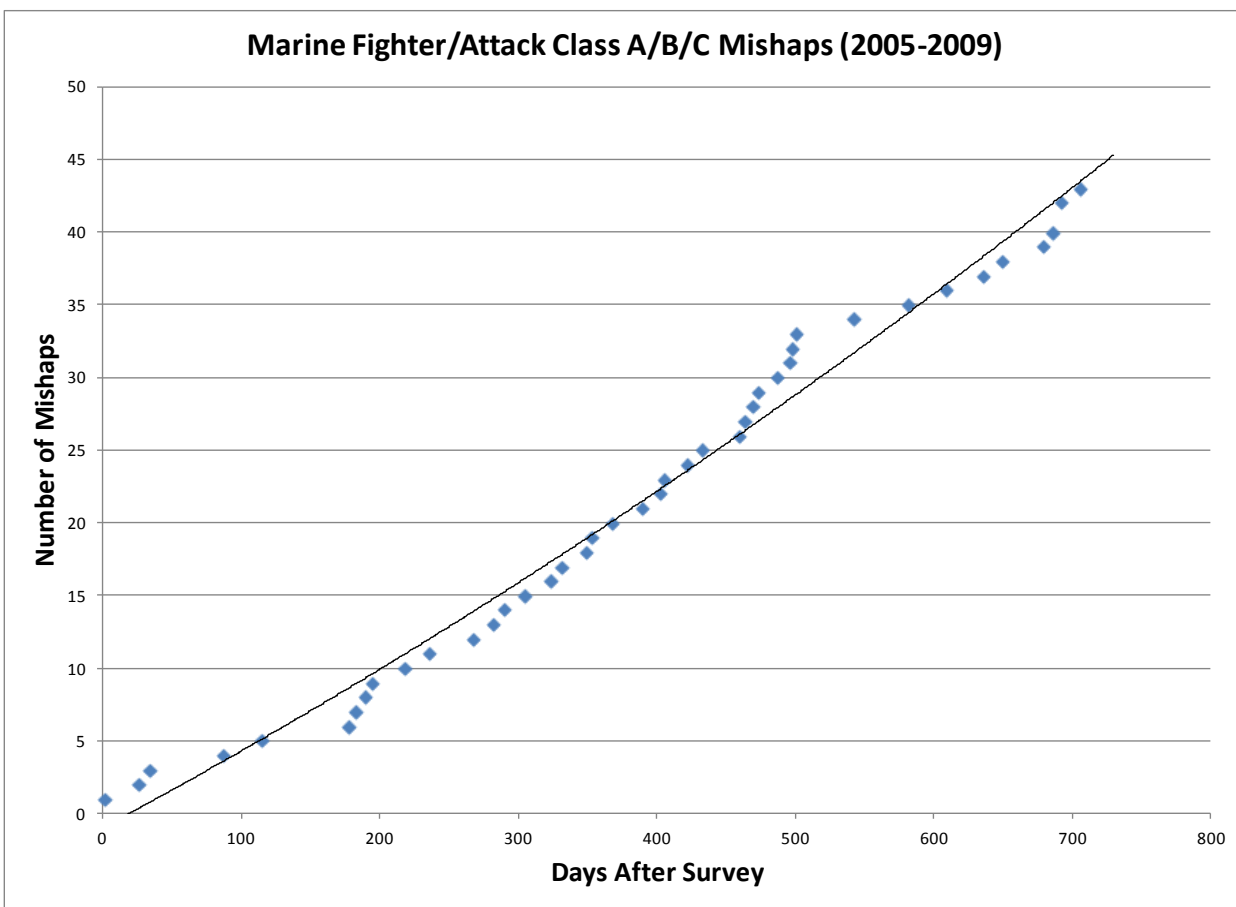**Fig A-6: VR Class A/B/C Mishaps**
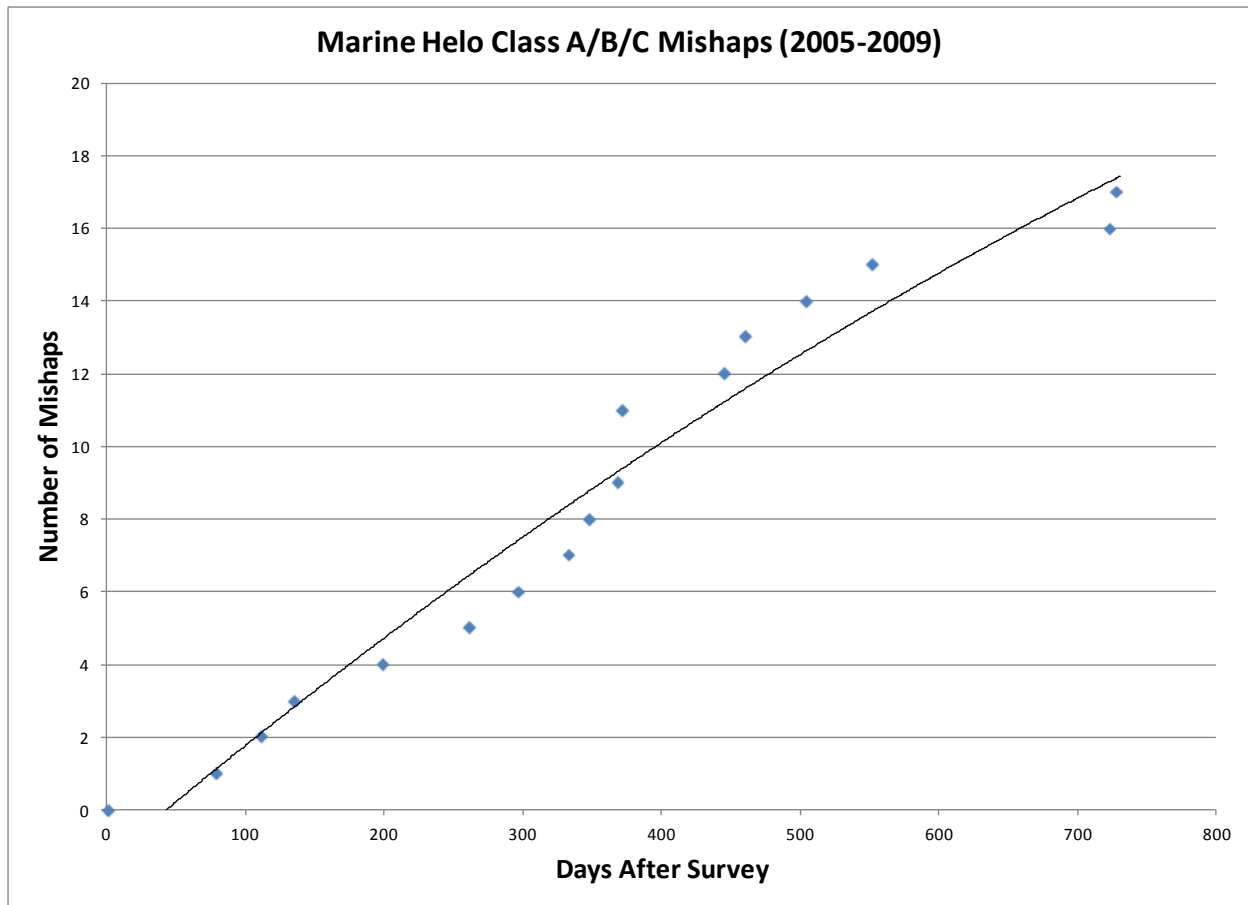
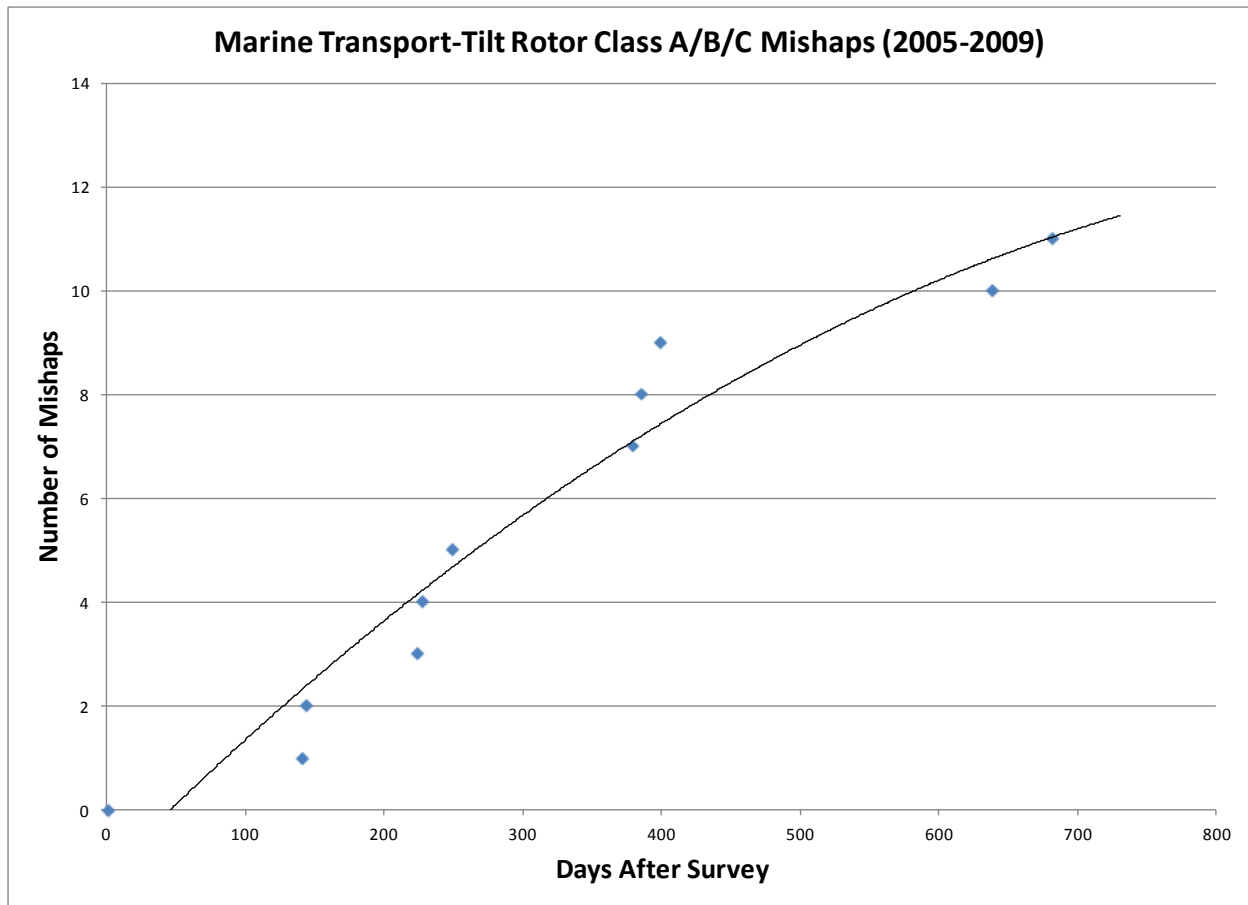Fig B-1: Fighter/Attack Class A/B/C

Fig B-2: Helo Class A/B/C Mishaps

Fig B-3: Transport/Tilt Rotor Class A/B/C Mishaps